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3.—Tropical spiny lobsters, *Panulirus* spp., of Western Australia (and the Indo-West Pacific)

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**Abstract**

Five species of spiny lobster *Panulirus penicillatus*, *P. versicolor*, *P. homarus*, *P. ornatus* and *P. polyphagus* inhabit waters of northwest Australia. The distributions of these and two other species *P. longipes* and *P. stimpsoni* all of which occur throughout the Indo-West Pacific region are described. Ecological separation of the widespread *Panulirus* species can be demonstrated and this results in regional dominance of one or other of the species depending upon local coastal conditions, particularly with respect to turbidity.

**Introduction**

In northern Australia, spiny lobsters are commonly referred to as "coral" or "green crayfish" in allusion to their supposed habitat and to the dominant colour of the common species *Panulirus versicolor*, *P. ornatus* and *P. homarus*. The two other species which occur in the general area are *P. penicillatus* which is brown and *P. polyphagus* which is blue-grey. None is restricted to live coral. Elsewhere in the Indo-West Pacific one or the other of these species supports a commercial fishery.

In an experimental fishing test in the Onslow region of Western Australia Mr B. K. Bowen (pers. comm.) set 15 Canadian and 6 Aden-type traps and he concluded that for *P. homarus* at least, the failure of the traps to take any spiny lobster was due to suspended clay and the surge of the tide. Diving and beach collections showed that four species occurred in the Onslow area. Apart from these observations by Mr B. K. Bowen and other reports by George & Holthuis (1965) and George (1966) which deal only with specimen descriptions or locality records, information on the abundance, habitat preferences or behaviour of the northern tropic Australian spiny lobsters is sparse.

This paper assembles existing published information on the ecology of these species around Australia and elsewhere, integrates this with personal observations, and proposes an explanation for their regional and local abundance.

I wish to acknowledge the opportunity afforded by F.A.O./U.N. to work in East Aden on *Panulirus homarus* (FAO/UN, 1963) and also that afforded by Ross Fisheries (Australia) Pty Ltd to study in the western Indian Ocean. My early observations on the northern coasts of Western Australia were carried out whilst employed by the C.S.I.R.O. Division of Fisher-

ies and Oceanography. I also wish to acknowledge the assistance of Dr G. M. Storr and Mr R. J. McKay of the Western Australian Museum for their critical discussion.

**Key to tropic Indo-Pacific *Panulirus*, based on colour markings**

- |   |   |                        |
|---|---|------------------------|
| 1. Abdomen with transverse pale bands   | 2 |                        |
| Abdomen without pale bands  | 3 |                        |
| 2. Legs striped; general colour dark green  |   | <i>P. versicolor</i>   |
| Legs spotted; general colour grey-blue  |   | <i>P. polyphagus</i>   |
| 3. Abdomen with many very fine pale spots all over dorsal surface   | 4 |                        |
| Abdomen without small spots on dorsal surface; general colour green   |   | <i>P. ornatus</i>      |
| Abdomen with moderate number of moderate sized spots; general colour red-brown  |   | <i>P. longipes</i>     |
| 4. Legs spotted or blotched; general colour light green or blue-green   | 5 | <i>P. homarus</i>      |
| Legs striped  |   |                        |
| 5. Side of abdomen with short white vertical line and conspicuous white spots on each segment; general colour drab    |   | <i>P. stimpsoni</i>    |
| Side of abdomen uniformly spotted without white line or conspicuous spot on each segment; general colour brown or red |   | <i>P. penicillatus</i> |

**Key to tropic Indo-Pacific *Panulirus*, based on morphological features**

- |   |   |                        |
|---|---|------------------------|
| 1. Each abdominal segment with a transverse groove  | 2 |                        |
| Abdominal segments without transverse grooves   | 4 |                        |
| 2. Anterior margin of abdominal grooves scalloped   |   | <i>P. homarus</i>      |
| Anterior margin of abdominal grooves not scalloped  | 3 |                        |
| 3. Antennular plate with 4 equal principal spines fused at base   |   | <i>P. penicillatus</i> |
| Antennular plate with 2 principal spines and some smaller spines behind   |   | <i>P. longipes</i>     |
| 4. Flagellum of exopod of second maxilliped well-developed, multi-articulate  |   | <i>P. polyphagus</i>   |
| Flagellum of exopod of second maxilliped small or absent  | 5 |                        |
| 5. Male pleopod three times as long as wide; carapace not pubescent; abdomen smooth in adult, faint transverse pubescent areas in juveniles |   | <i>P. versicolor</i>   |
| Male pleopod twice as long as wide; carapace with faint pubescence; abdomen always smooth and naked   |   | <i>P. ornatus</i>      |
| Male pleopod twice as long as wide; carapace with distinct pubescence; segments of abdomen with distinct sunken pubescent areas             |   | <i>P. stimpsoni</i>    |

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### Geographic distribution

Five of the six known species from Australian tropic waters occur in Western Australia. All six are dealt with here since it may only be a matter of time before the sixth is recorded from Western Australia. These species occur elsewhere through the Indo-West Pacific region (of which tropical Australia is a part) and only one further spiny lobster, *Panulirus stimpsoni* Holthuis 1963 from Hong Kong and China, is known from this vast area. In other words, all but one Indo-West Pacific *Panulirus* species occur in Australian waters. Details of geographic distribution are set out in Table 1. This is based on Holthuis' basic revision (1946) supplemented by regional appreciations conducted by Barnard (1950) for Natal and East Africa; Charbonnier and Crosnier (1961) for Madagascar; Deshmukh (1964), Chhapgar and Deshmukh (1964) and Satyanarayana (1961) for west Indian coast; De Bruin (1962) for Ceylon; Naiyanetr (pers. comm.) for west Thailand; Kubo (1954) for Japan; Rapson (1962) for New Guinea; Holthuis and Villalobos (1962) and Holthuis and Loesch (1957) for East Pacific offshore islands.

Three species, *P. penicillatus*, *P. longipes* and *versicolor* are notable for their ability to inhabit, in moderate or quite high numbers, islands which are well away from the relatively continuous coastal waters of the Indian and West Pacific Oceans. *Panulirus penicillatus* has the greatest ability to disperse and colonise, occupying 240° of longitude from the western Red Sea (30° East) to the Galapagos Is (90° West). It is the only spiny lobster to cross the Pacific Oceanic Barrier recognised by Eckman (1953), and would be called by Briggs (1961) a Transpacific species. Neither *P. longipes* nor *P. versicolor* has crossed the Pacific Barrier or even colonised as far east as Hawaii. The success of their larvae is apparently restricted by distances greater than about 1000 miles.

The other three fairly widespread species *P. homarus*, *P. ornatus* and *P. polyphagus* are only very occasionally able to successfully establish

far from mainland coasts (e.g. the presence of *ornatus* at Mauritius) and are essentially coastal species. *Panulirus stimpsoni* has the most limited distribution and is included in Table 1 to complete the distribution picture for all known tropic species of *Panulirus* in the Indo-West Pacific region.

### Ecological observations

De Bruin (1960 and 1962) has studied spiny lobsters in Ceylon for several years by diving and trapping. He has documented ecological and behavioural differences between some of the species and has provided the first indication that the localised dominance by a species in a given area is probably due to that species' ecological requirements being met by the particular environments available around Ceylon. His two publications serve as excellent basic studies for this paper. I have had the good fortune to dive with De Bruin on one of his nightly surveys; it was a very rewarding experience.

#### *Panulirus penicillatus*.

De Bruin (1962) found this species in small numbers on both east and west coasts of Ceylon and concluded that it occurs only in shallow waters subject to surf as exists on the rocky reef front. It is present in much larger numbers and is commercially exploited at Revillagigedo I. (Holthuis & Villalobos, 1962) and at Galapagos where it also prefers the shallow waters to 2 metres, displacing the east Pacific species *P. gracilis* from the shallow part of its normal range (Holthuis & Loesch, 1967).

In tropical Western Australia it is not abundant; moulted shells have been collected in low numbers along the beach inside the fringing reef which runs from Point Cloates to North West Cape. Presumably, the species lives out on the seaward reef edge. Commercial traps set for *P. cygnus* at Murchison River, Abrolhos and experimental surveys around

TABLE 1

Distribution of tropical Indo-West Pacific *Panulirus*

(0=no authentic record; +=relative abundance)

	penicillatus	longipes	versicolor	homarus	ornatus	polyphagus	stimpsoni
Natal	+	0	+	++	0	0	0
Madagascar	++	+	+	++	+	0	0
East Africa	+	+	+	+	+	0	0
Red Sea (proper)	++	0	0	+	+++	0	0
South Arabian Coast	+	0	+	0	0	0	0
Indian Coast, West	+	0	+	+++	+	0	0
Ceylon	+	+	+	+	+	++++	0
Bay of Bengal	0	0	++	+++	++	+	0
West Thailand	+	0	0	0	+	0	0
China Sea and East Indies	0	+	+	+	+	+	0
Japan and Formosa	+	+	+	+	+	+	Hong Kong
N. Australia	+	+	+	+	+	0	0
New Guinea	+	0	+	+	+	+	0
South-West Pacific	++	+	+	+	++	0	0
Central Pacific	+	+	+	0	+	0	0
Hawaii	+	0	+	0	0	0	0
E. Pacific offshore islands (Galapagos and Revillagigedo)	++++	0	0	0	0	0	0
Indian Ocean offshore islands	Mauritius	Mauritius	Cocos I	0	0	0	0
	Reunion	Reunion	Seychelles		Mauritius		
	Seychelles	Seychelles	Christmas I.				
	Chagos	Christmas I.					
	Christmas I.						
	Cocos I.						

Monte Bello Island have yielded very occasional specimens. Although the species will enter baited traps (see also Charbonnier and Crosnier 1961 and De Bruin 1962) it is commercially taken by hand at the Galapagos; it is fairly docile, and makes little attempt to back away into the normal retreats of spiny lobsters when approached by a gloved hand (Holthuis and Loesch, 1967). This has also been observed by R. J. McKay (pers. comm.) at Black Ledge off Onslow, W. Australia.

It is not necessarily restricted to coral reef, and in fact Charbonnier and Crosnier (1961) suggest that it occurs on the south coast of Madagascar because these rocky areas lack coral; one can also conclude that clear, non-turbid water conditions such as exist on oceanic islands are preferred conditions.

#### *Panulirus longipes*

De Bruin (1962) used the name *P. japonicus* for this species but George and Holthuis (1965) have shown that Ceylon specimens such as De Bruin figured are the spotted-leg form of *P. longipes*. The other form which has striped legs occurs mainly in the west Pacific and so far has not been found sympatric with the Indian Ocean spotted-leg form. This species has not yet been recorded from northern Australia but it occurs around this region at Christmas I., New Guinea and Heron I., Great Barrier Reef.

De Bruin (1962) found *P. longipes* on both coasts of Ceylon but nowhere in abundance. It preferred the seaward edge of the reef plateau at depths of 6-14 metres i.e. below the shallow range of *P. penicillatus*. Since I have collected *P. longipes* in very shallow water (1-2 metres depth) at Mauritius, Seychelles, and Heron I., Great Barrier Reef, it is possible that at Ceylon *P. longipes* (like *P. gracilis* at Galapagos) is displaced by *P. penicillatus* in shallow waters.

Although *P. longipes* enters traps it has not been commercially exploited to any extent anywhere in spite of its obvious nocturnal habits even on moonlight nights (De Bruin 1962). Substrate and temperature preferences are broad in this species since I have collected them in the shallow, very warm, coral reefs of Mauritius, Seychelles and Heron I., and they have also been taken in traps set on rocky bottom for *Jasus verreauxii* in the subtropic waters of southern Queensland at a depth of 130 metres (George & Holthuis 1965). Although its temperature and depth ranges are wide, it apparently prefers non-turbid waters as does *P. penicillatus*.

#### *Panulirus versicolor*

De Bruin (1962) found this species to be dominant on the east coast of Ceylon and to occur in depths greater than 6 metres. They are extremely gregarious but since they do not enter pots his assessment of their relative abundance had to be carried out by diving.

His conclusions are confirmed by personal observations except that in places such as Heron I. (Qld.), North West Cape, Thevenard and Lowendal Is. (Western Australia), East Aden, and Seychelles *P. versicolor* also occurs in shallow waters of less than 6 metres. Perhaps

at Ceylon, where all species occur in close proximity to one another, depth displacement of species is most obvious.

In northern Australia *P. versicolor* is probably the most common of all the tropic spiny lobsters (B. K. Bowen pers. comm.). Its adult habitat includes waters and substrates which contain some fine sediment (e.g. on the shallow reef flat at Thevenard I.) as well as substrates of prolific coral where the waters are very clear. Juveniles apparently prefer clearer rather than muddier conditions. At Lowendal I. and on the outer face of the fringing reef at Thevenard I. where there is constant movement of very clear water, many juveniles have been observed with their bodies neatly fitting into holes in the reef, leaving their long white antennae protruding.

#### *Panulirus homarus*

Gordon (1953) correctly regarded *P. homarus* as a morphologically variable species which includes forms previously named as *P. dasypus* and *P. burgeri*. The variability is most apparent in the degree of scalloping and the completeness of the abdominal grooves as well as the number of joints on the flagellum of the second maxilliped (De Bruin 1962). In Ceylon, De Bruin (1962) found that *P. homarus* was the most promising spiny lobster for exploitation since it was the most abundant, it enters baited traps, it occurs from shallowest reef front to the deepest fissures in granite (14 metres) and it is extremely gregarious.

In East Aden the above observations on behaviour and habitat were confirmed and it was concluded that it is promising for exploitation (FAO/UN 1963). That report mentioned that *P. homarus* also occurs on volcanic or limestone reefs and that the cooler, poor-coral coasts of East Aden which are influenced by upwelling in the Gulf of Aden are optimal for it. Heavy seas and flash floods occur during the monsoon and weed dislodges at the end of the monsoon season. This results in a seasonal alternation of cloudy, turbid conditions during the monsoon (June to September) and crystal clear conditions during the remainder of the year.

In northern Australia *P. homarus* is recorded from Broome and near Onslow on beaches and nearby islands. As noted by Mr B. K. Bowen (pers. comm.) the conditions here are always turbid to some degree due to the great rise and fall of tide in an area where wind-blown desert dust and irregular, summer-flowing rivers provide the fine sediments. Mr R. J. McKay (pers. comm.) reports that adults usually occur in clearer water than juveniles and the juveniles can be found in very muddy conditions. Just off the Onslow beach he pulled 2 inch specimens from close-fitting holes in dead coral heads by their very long, deep maroon antennae. It is possible that muddy water is necessary for the juveniles of *P. homarus* and that although the adults can tolerate occasional turbidity they prefer cooler, clearer water. These conditions occur at East Aden; the water temperature is lowered due to upwelling at the time of the monsoon and the turbid water condition can be due to either run off after flash floods or to disturbance of fine sand by heavy seas.

*Panulirus ornatus*

In Ceylon this species is dominant on the northern coast, lives singly or in pairs in shallow water, and its density can only be estimated by diving since it does not enter traps (De Bruin 1962). In Western Australia it has been collected from several localities near North West Cape, Thevenard I. near Onslow, Dampier Archipelago and Broome either by shallow diving near reefs or hand collecting on the reef flats and beaches (moulted shells).

Charbonnier and Crosnier (1961) suggest that *P. ornatus* prefers the corals of Madagascar but at Lamu on the East African coast where a hand fishery for *P. ornatus* operates, conditions are generally turbid and not good for coral growth. At Mauritius, I was told by divers that *P. ornatus* occurs inside the lagoon in the deeper channels that run from small rivers across to the outer edge of the fringing reef. Here the water conditions are certainly cloudy due to the fine coral sediment of the lagoon supplemented by some terrestrial detritus derived from the streams.

The specimens which were collected near North West Cape, Western Australia, were taken from their shelter beneath an oyster-covered rock off Melyering Beach; the water depth was about 2 metres and the whole of the bottom of the pool as well as the offshore reef surrounding it was covered with a very fine white sediment which was very easily stirred up by a diver's swim fins. *P. ornatus* appears not only to tolerate but to prefer areas subjected to regular or occasional turbid conditions.

*Panulirus polyphagus*

This species was only recorded once by De Bruin (1962) trawled on a sea bottom of mud on the north east coast of Ceylon. There are four specimens of *P. polyphagus* from northern Australian waters in the collection of the Western Australian Museum; these are from Broome, Derby, Joseph Bonaparte Gulf and Darwin.

*P. polyphagus* is the dominant species on the upper west coast of India; it is taken by hoop nets or by trawling to depths of at least 70 metres and constitutes 99% of the commercial catch (Deshmukh, 1964). Because *P. polyphagus* can be taken by traps or by trawl, its absence in quantities over most of the Indo-West Pacific zone can be regarded as real and it can be concluded that the preferred habitat for this species is typified by the muddy upper west coast of India.

**Discussion**

Ecological separation of the 6 sympatric species of the Indo-West Pacific region is indicated since regional or habitat dominance can be demonstrated. On the regional scale, *P. ornatus* is the dominant species in East Africa, *P. homarus* on the South Arabian coast, *P. polyphagus* on the Indian west coast and *P. penicillatus* on the east Pacific offshore islands. On a much smaller scale, personal observations at three localities in the North West Cape area of Western Australia have shown that on the limestone reef directly below the North West Cape Lighthouse, only *P. cygnus* (the dominant west coast and com-

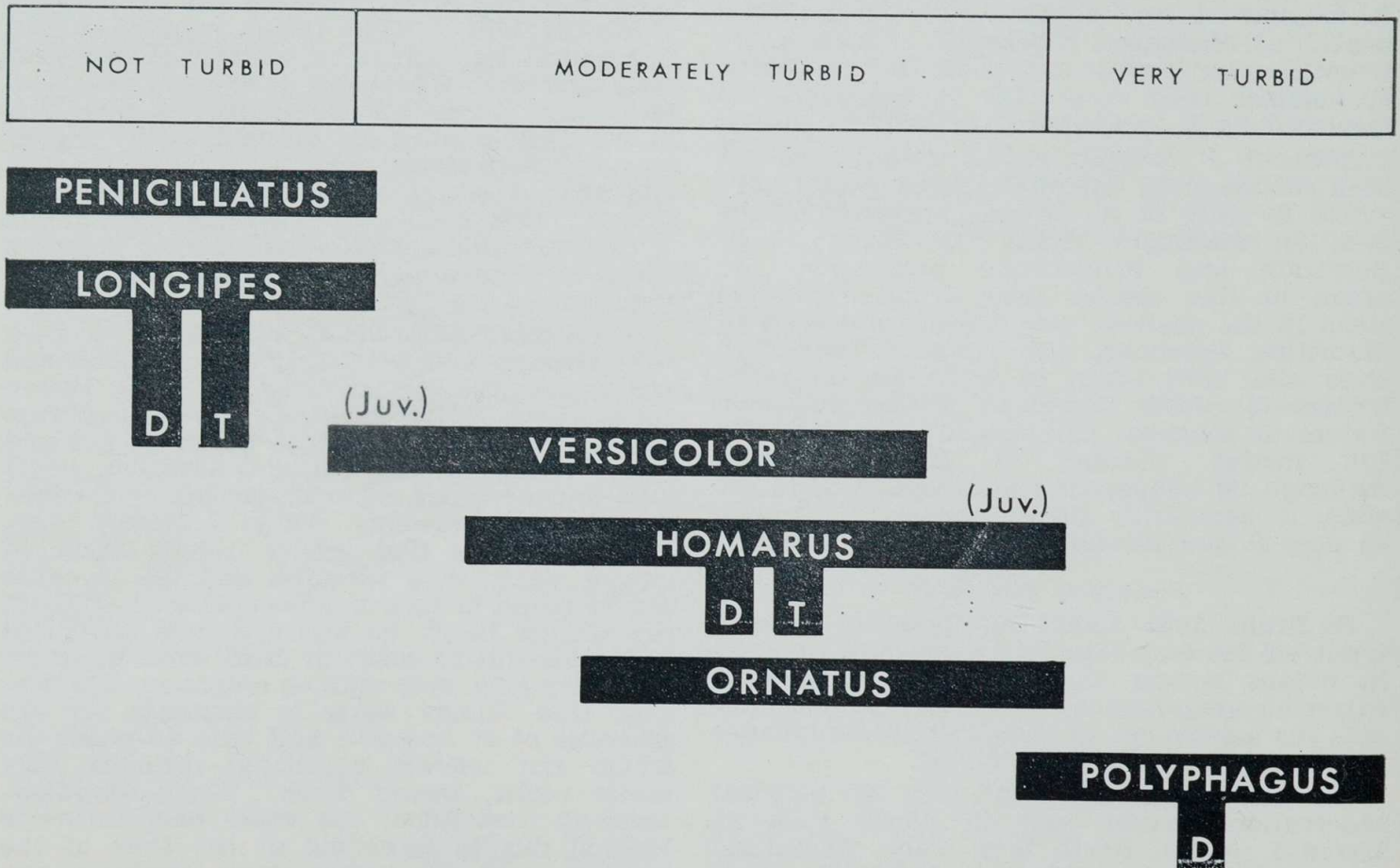


Figure 1.—Comparison of habitats occupied by tropical Indo-West Pacific *Panulirus* spp. with respect to turbidity, depth and temperature. D and T represent degree of habitat extension into deeper (D) and cooler (T) waters below the shallow tropic habitat, common to all six species.

mercially important spiny lobster) is found while 3 miles to the northeast among the coral at the North West Cape reef only *P. versicolor* occurs, and 20 miles southwest of the North West Cape Lighthouse, in the pool with fine sediment at Melyering Beach *P. ornatus* was the only species found.

A fullscale investigation would probably reveal numerous environmental factors which could lead to the observed ecological and habitat separation of these species. However, turbidity of the water, type of substrate, depth and temperature are the only ones that can be considered here because of the lack of data pertaining to other factors. For example, at least three other ecological factors (food, salinity and oxygen) should be considered, but our knowledge of the comparative requirements of these for any of the species is non-existent.

Figure 1 compares habitats occupied by the tropic spiny lobsters with respect to water turbidity, depth and temperature. Substrate has not been included since it can be modified by interaction of the three previously mentioned factors. For example "live coral" as a substrate can be abundant in regions of very low turbidity, high temperature and shallow depth but can be very sparse where any one of these factors is limiting. Also substrates of "mud" can be produced by entirely different processes; fine terrigenous sediment can be carried into the sea by river or wind or it can be produced by the breakdown of skeletons of marine organisms or by chemical processes. It is not possible at this stage to suggest whether spiny lobsters discriminate between these mud sources or not.

If Figure 1 does represent major ecological influences determining the occurrence and abundance of tropical spiny lobsters, then one would expect that the densities of each species would decrease as the limits of the "normal" geographic (or ecologic) range are approached. Some support is given to this expectation by the following observations.

On the eastern side of the Arabian Sea the degree of turbidity in the sea increases as one progresses from Galle, Ceylon, up the west coast of the Indian Peninsula. In the northern regions near Karachi and Bombay, the seasonal onshore monsoon results in heavy run-off of terrestrial sediment which replenishes the extensive mud areas at the coast; along the lower part of the Indian Peninsula, the amount of sediment carried into the sea is very much less because the rivers are short and run through the hard rocks of the Western Ghats. *P. penicillatus* which prefers clear water is in low density on the west coast of Ceylon (De Bruin, 1962) and has been recorded only once from India and then from the southern State of Kerala (Satyanarayana, 1961). *P. longipes* which also prefers clear waters occurs in low numbers in Ceylon but has never been recorded from India. *P. homarus* is the most abundant species on the west coast of Ceylon (De Bruin, 1962) and at Kerala State, India (Satyanarayana, 1961) and it extends in low numbers as far as Bombay (Deshmukh, 1964). *P. polyphagus* occurs rarely at Ceylon, but at Bombay and Karachi it predominates and is

taken commercially. Although *P. versicolor* and *P. ornatus* do occur along the Indian and Ceylonese west coasts, relative densities are difficult to assess. However on the east coast of Ceylon it is reasonable to suggest that *P. homarus* which dominates the north coast inhabits muddier conditions than the dominant *P. versicolor* on the mid-east coast (see De Bruin, 1962).

The relative abundance of spiny lobsters along the Indian and Ceylonese coasts warrants comparison with the situation along the north-west coast of Australia. Apart from the very muddy conditions in Exmouth Gulf and Nickol Bay, the region from North West Cape to Broome is slightly turbid compared with the region east of Broome which is very turbid. Many physical factors contribute to the amount of turbidity in the coastal waters of a particular region but the most direct contribution is by large rivers carrying high concentrations of sediments. This is exemplified in India by the Indus which discharges near Karachi and in the northwest of Australia by the river systems which discharge between Derby and Darwin. Where muddy river discharge is not dominant, a region may be characterised by wind-borne sediment (e.g. along the desert coast between Broome and Onslow where offshore winds occur) or by local *in situ* contributions of fine sediment of organic origin (e.g. in Shark Bay, Western Australia). The rise and fall in tide also appreciably affects turbidity where this is great such as along the northwest coast of Australia.

In the clear waters just to south of North West Cape *P. penicillatus* occurs, but it only extends to the east on offshore islands such as the Monte Bellos and at Black Ledge where clear conditions exist. *P. polyphagus* on the other hand has only been recorded in the eastern part from Broome to Darwin; its abundance would be better known when trawling operations commence on the muddy bottoms which hold promise of penaeid prawn fisheries.\* In the region of moderate turbidity between Onslow and Broome *P. ornatus* and *P. homarus* occur fairly close to the coast whereas *P. versicolor* prefers the clearer areas further offshore. One unexpected absentee from the North West Cape region is *P. longipes*. It has good dispersal powers, tolerates subtropical temperatures and prefers clear waters such as exist south of North West Cape. Perhaps its place is taken on the subtropic west coast by the dominant *P. cygnus* whose ecological ranges and preferences appear to be very similar to the subtropic part of the *P. longipes* range.

#### References

- Barnard, K. H. (1950).—Descriptive catalogue of South African decapod Crustacea. *Ann. S. Afr. Mus.*, 38: 1-864.  
Briggs, J. C. (1961).—The east Pacific barrier and the distribution of marine shore fishes. *Evolution*, 15: 545-554.

\* Note added in press. Recently exploratory prawn trawling by the Department of Fisheries and Fauna in the region between Admiralty Gulf and the western side of Joseph Bonaparte Gulf has shown that the only species of *Panulirus* trawled was *P. polyphagus*; about 20 specimens were taken in the prawn nets in April 1968.

- Chhapgar, B. F. & Deshmukh, S. K. (1961).—On the occurrence of the spiny lobster, *Panulirus dasyopus* (H. Milne-Edwards) in Bombay waters, with a note on the systematics of Bombay lobsters. *J. Bombay nat. Hist. Soc.*, 58: 632-638.
- Charbonnier, D. & Crosnier, D. (1961).—Quelques données sur la pêche des langoustes à Madagascar. *pêche marit.*, no. 994: 1-3.
- De Bruin, G. H. P. (1960).—Lobster fishing in Ceylon. *Bull. Fish. Res. Stn Ceylon*, no. 9: 1-18.
- De Bruin, G. H. P. (1962).—Spiny Lobsters of Ceylon. *Bull. Fish. Res. Stn Ceylon*, no. 14: 1-28.
- Deshmukh, S. (1964).—Epizoic associates of the Bombay Spiny Lobster *Panulirus polyphagus* (Herbst). *J. Bombay nat. Hist. Soc.*, 61: 150-160.
- Eckman, S. (1953).—Zoogeography of the sea. William Clowes, London.
- FAO/UN, (1963).—Report to the Government of Aden on the Crawfish Resources of Eastern Aden Protectorate. Based on the work of R. W. George. Rep. FAO/EPTA, (1696) 1-23.
- George, R. W. (1966).—Marine crayfish or spiny lobsters of Australia. *Fish. Newsl. Canberra*, 25 (5): 25-28.
- George, R. W. & Holthuis, L. B. (1965).—A revision of the Indo-West Pacific spiny lobsters of the *Panulirus japonicus* group. *Zool. Verh., Leiden*, 72: 1-36.
- Gordon, I. (1953).—On the Puerulus stage of some spiny lobsters (Palinuridae). *Bull. Br. Mus. nat. Hist. (Zool.)*, 2: 17-42.
- Holthuis, L. B. (1946).—The Decapoda Macrura of the Snellius Expedition. *Temminckia*, 7: 1-178.
- Holthuis, L. B. (1963).—Preliminary descriptions of some new species of Palinuridea (Crustacea, Decapoda, Macrura, Reptantia). *Proc. Acad. Sci. Amst. (ser. c)*, 66: 54-60.
- Holthuis, L. B. & Villalobos, A. (1962).—*Panulirus gracilis* Streets y *Panulirus inflatus* (Bouvier), dos especies de langosta (Crustacea, Decapoda) de la costa del Pacifico de America. *An. Inst. Biol. Univ. Mex.*, 32: 251-276.
- Holthuis, L. B. & Loesch, H. (1967).—The lobsters of the Galapagos Islands (Decapoda, Palinuridae). *Crustaceana*, 12: 214-222.
- Kubo, I. (1954).—Systematic studies on the Japanese macrurous decapod Crustacea. 3. On the palinurid lobsters. *J. Tokyo Univ. Fish.*, 41: 95-105.
- Rapson, A. M. (1962).—The tropical crayfish (*Panulirus ornatus* Fabricius) in southern Papuan waters. *Fish. Bull. Papua* no. 2 1-17 + 2 appendices.
- Satyanarayana, A. V. V. (1961).—A record of *Panulirus penicillatus* (Olivier) from the inshore waters off Quilon (Kerala). *J. mar. biol. Ass. India*, 3 1: 2.